Apr 5th, 1:45 PM - 2:00 PM

Key factors influencing change in Pacific herring populations: a qualitative network model approach

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Key factors influencing change in Pacific herring populations:

a qualitative network model approach

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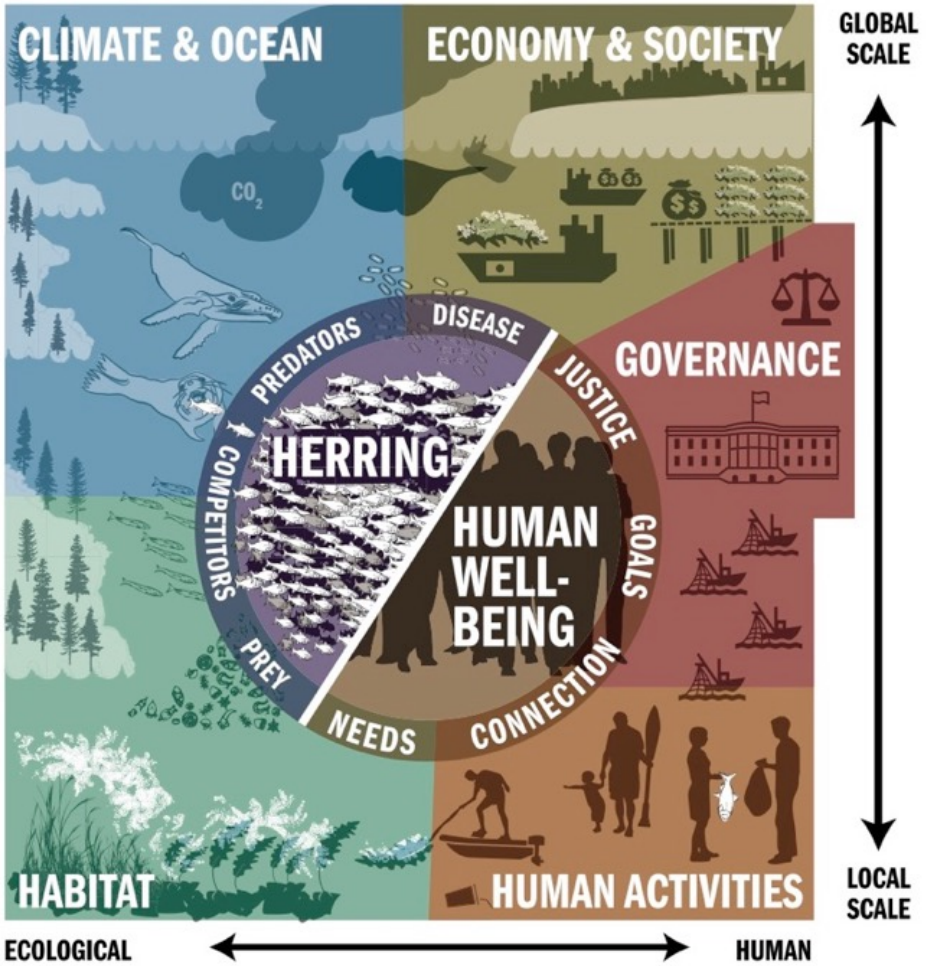
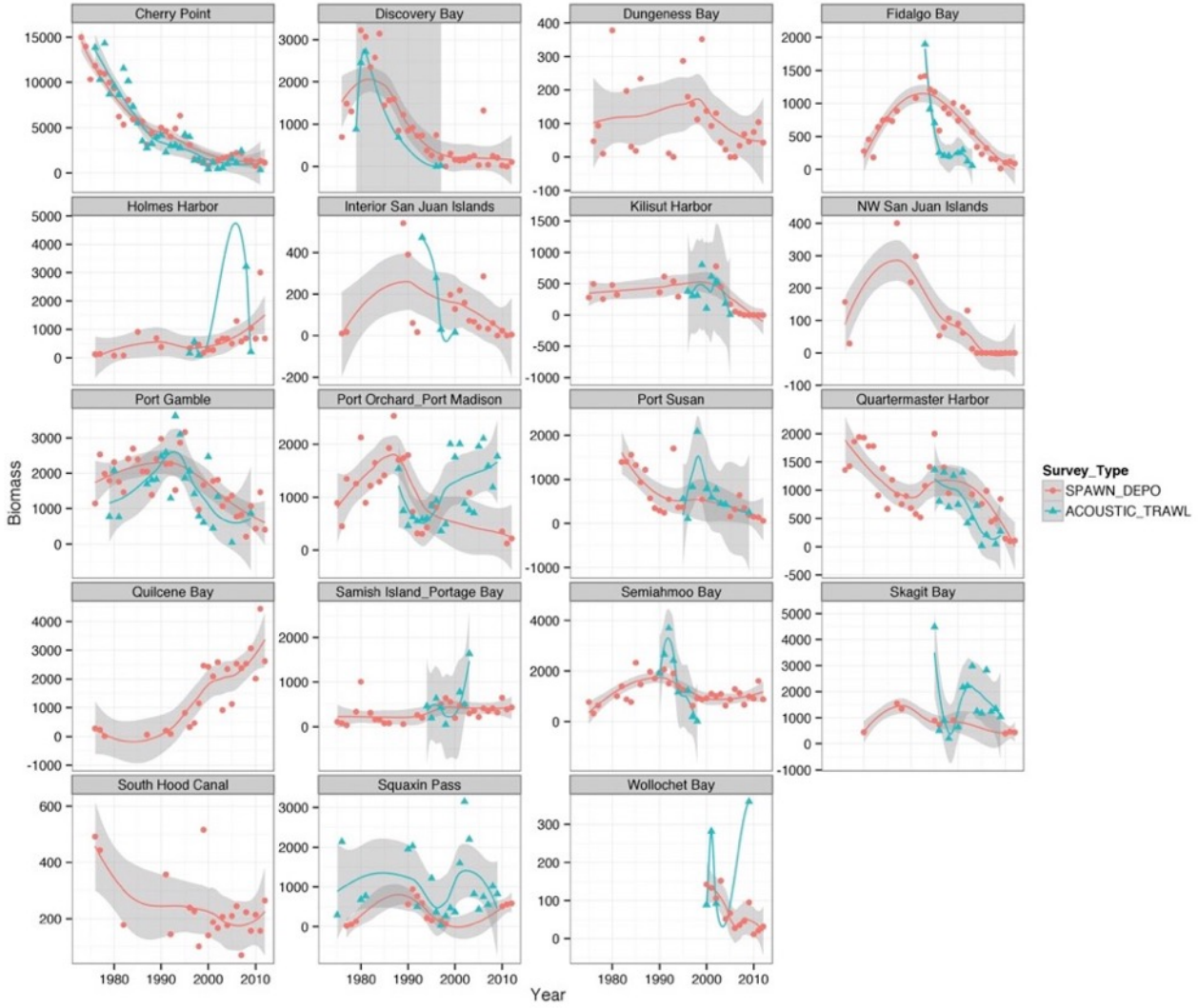
I. McAllister



Levin, Francis and Taylor 2016

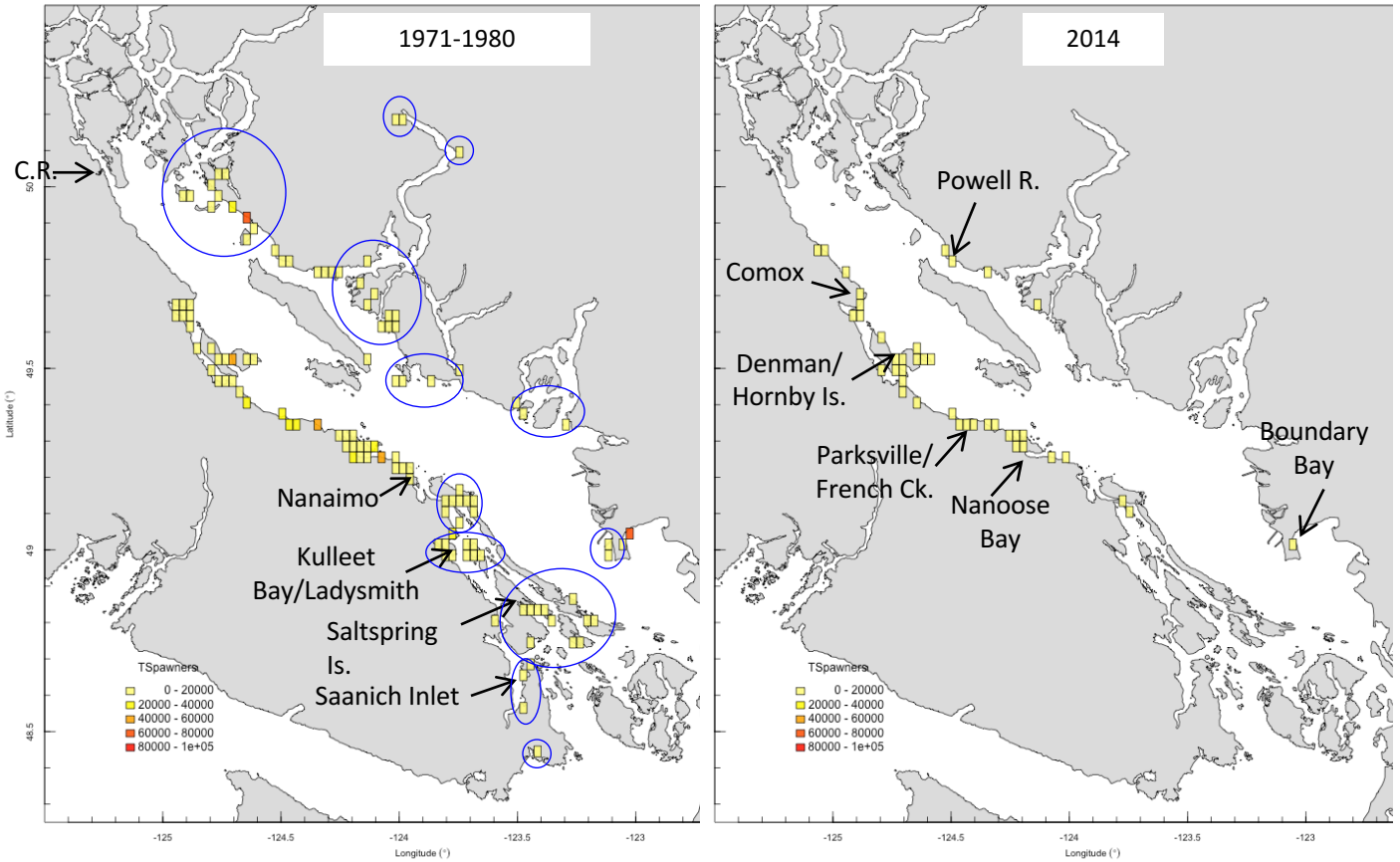
Image by Sam Bradd @sambradd

Herring declines in Puget Sound

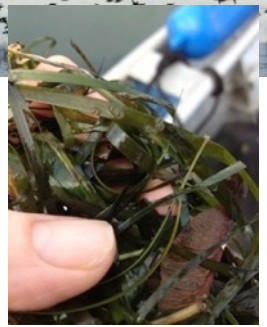


Siple and Francis 2016

Herring distribution shifts in Strait of Georgia

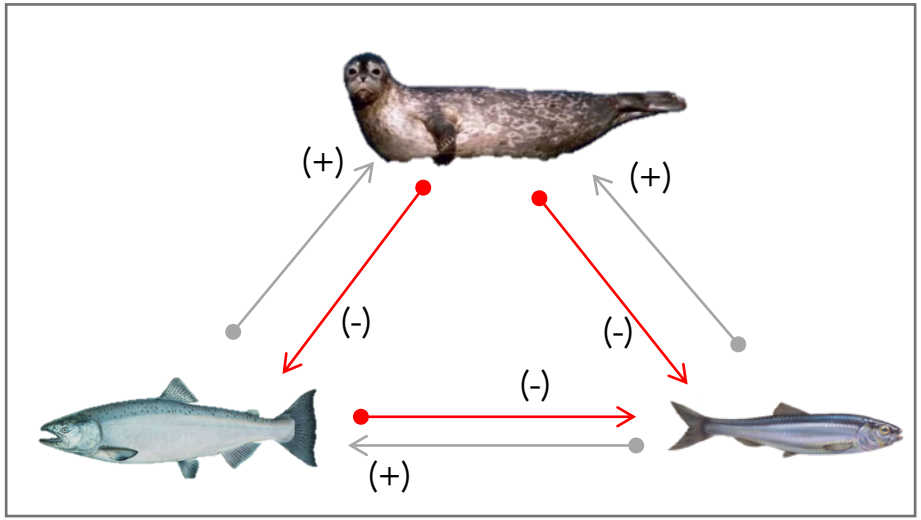


Slide courtesy of Jaclyn Cleary



Qualitative Network Models

- Based on conceptual models of ecosystem structure & function
- Used to test assumptions about important interactions, compare against observations
- Bridge to complex ecosystem models
- Can link social & ecological systems
- Decision support tool – not tactical

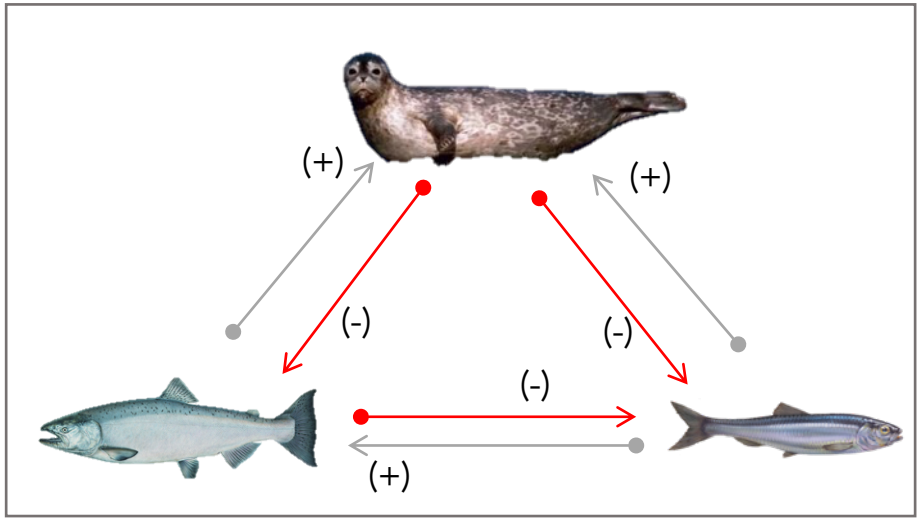


Melbourne-Thomas et al. 2012

QPress package and modifications in R

Qualitative Network Models

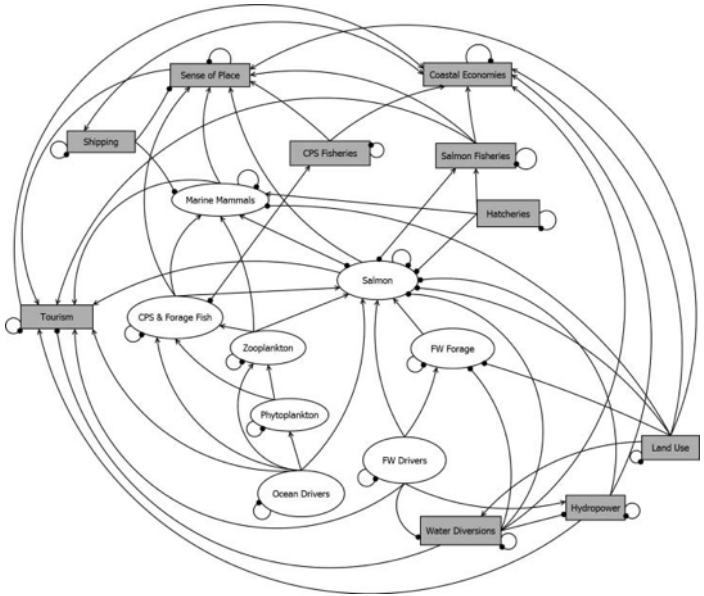
1. Identify nodes & links
2. Assign relationships (+), (-) or (0)
3. Simulate perturbation to one part of system
4. Draw from distribution of possible interaction strengths, identify stable solutions
5. Evaluate probability of positive or negative response across system



Melbourne-Thomas et al. 2012

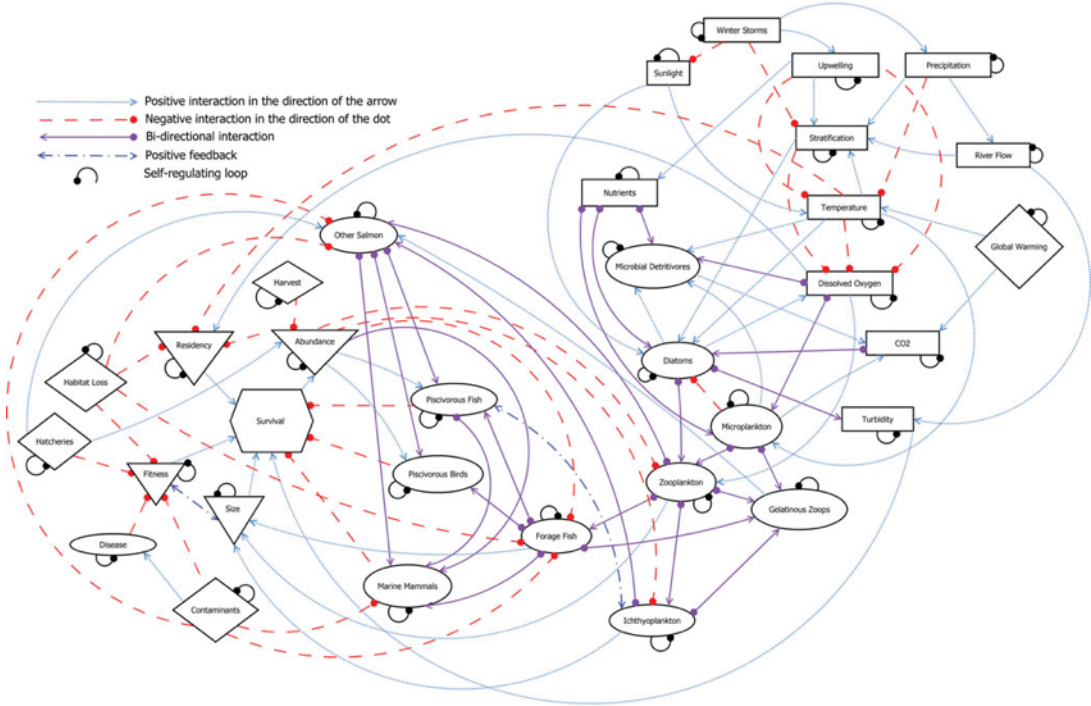
QPress package and modifications in R

California Current



Harvey et al. 2016

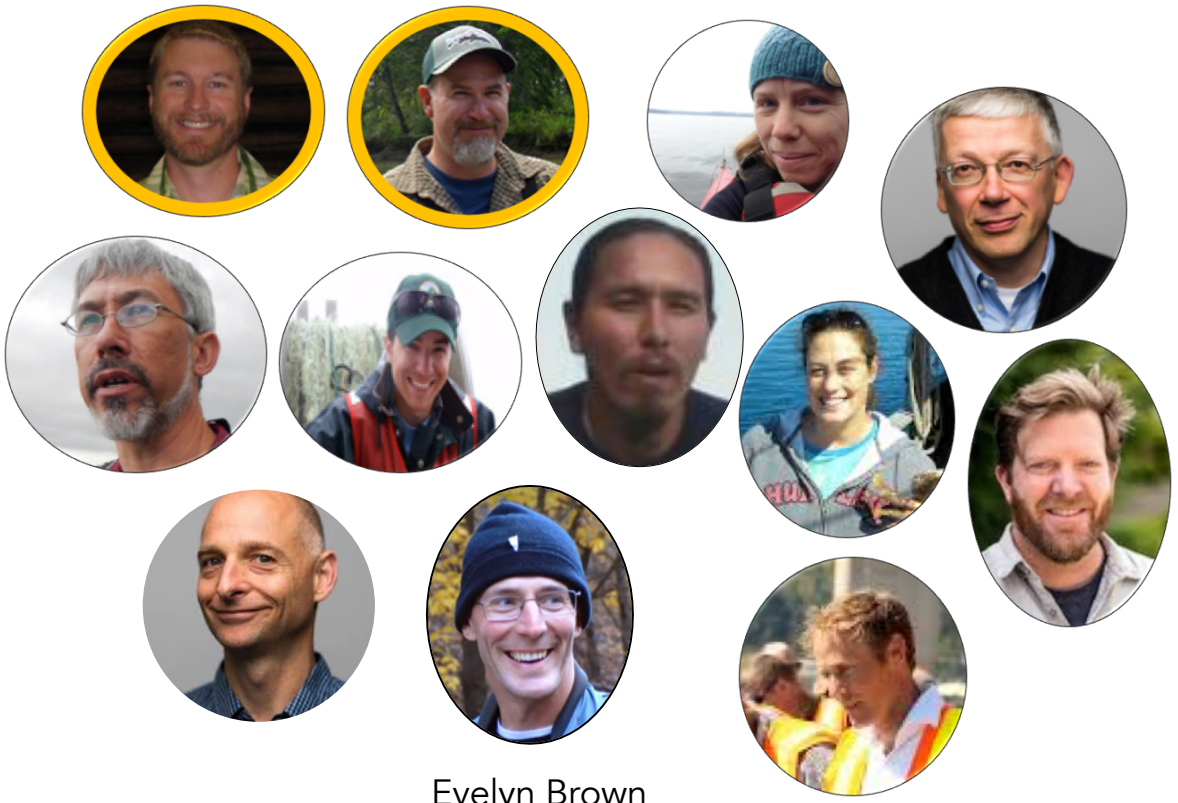
Salish Sea



Sobocinski et al. 2017

Conceptual Model Development

- What are the primary factors influencing recent change in herring abundance or distribution?
- What are the key ecosystem interactions?



Evelyn Brown
Doug Hay
Chad Ormond

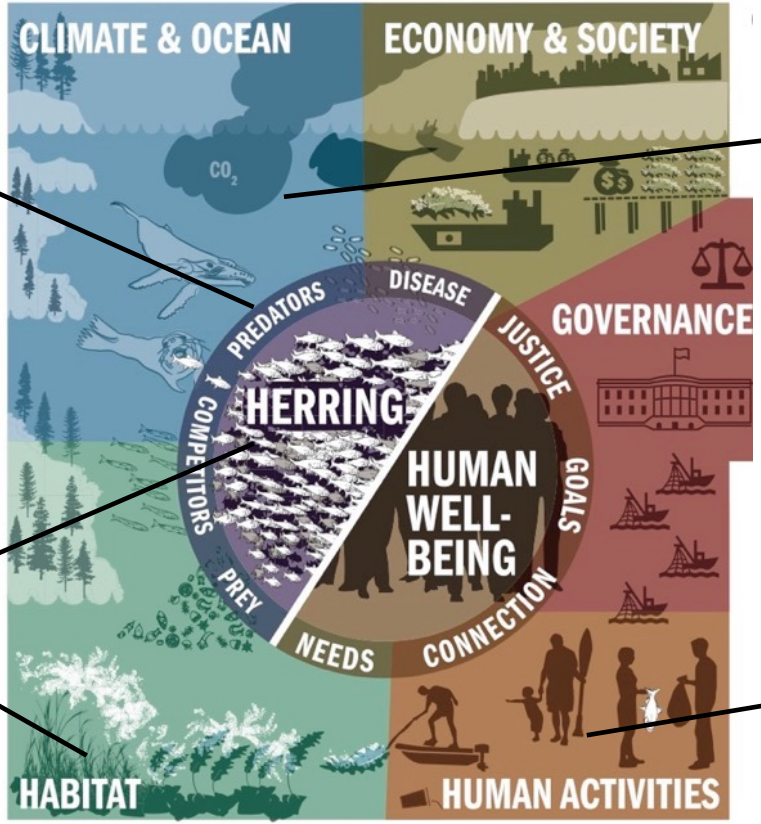
The Herring Conceptual Model

Orcas
Other piscivorous whales
Pinnipeds
Porpoises
Piscivorous birds
Piscivorous fish
Dogfish
Demersal fish
Planktivorous fish
Beach spawning fish
Ovivores
Jellyfish

Benthic invertebrates
Zooplankton
Micro-zooplankton
Phytoplankton

Disease

Turbidity



Eggs, larvae, juveniles, adults

Physical habitat
Biogenic habitat

Contaminants

STRAIT OF GEORGIA

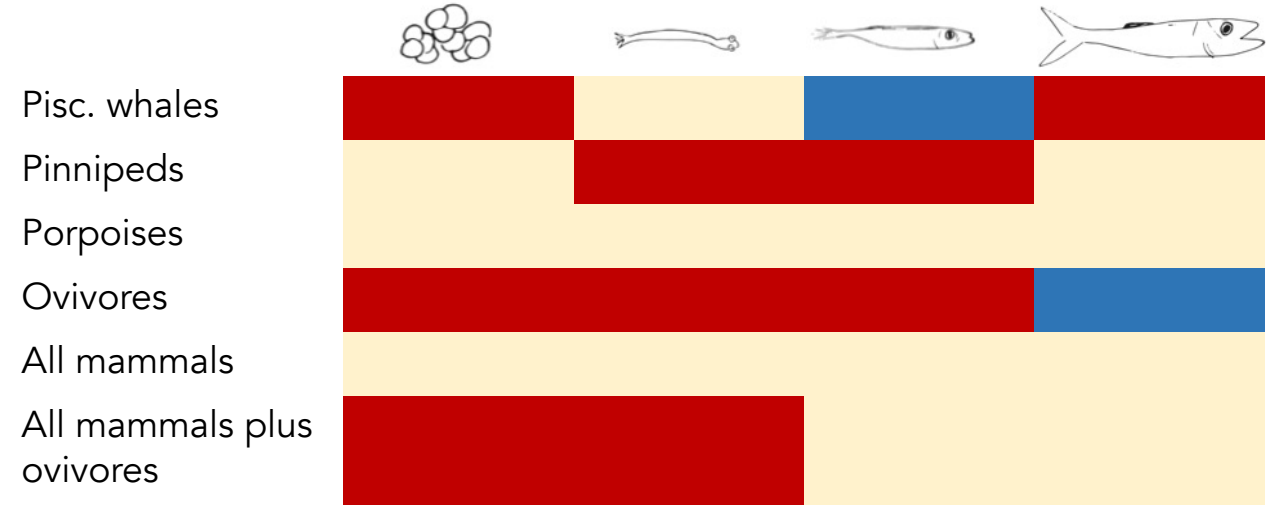
Scenario: PREDATION

↑ WHALES

↓ eggs, adults

perturbation

response



Out of 10,000 stable model solutions

Strongly negative (>80% of runs)

Neutral (20-80%)

Strongly positive (>80% of runs)

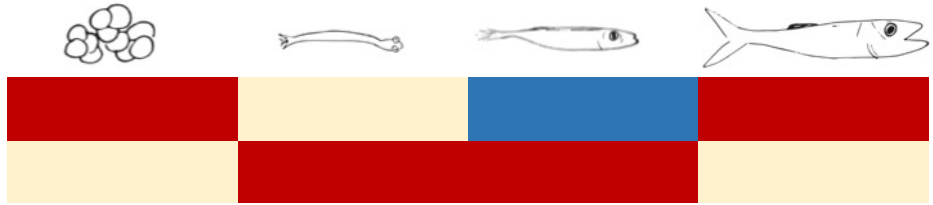
Scenario: PREDATION

↑ WHALES PINNIPEDS

↓ eggs, adults larvae, juvs

perturbation

response



Out of 10,000 stable model solutions

Strongly negative (>80% of runs)

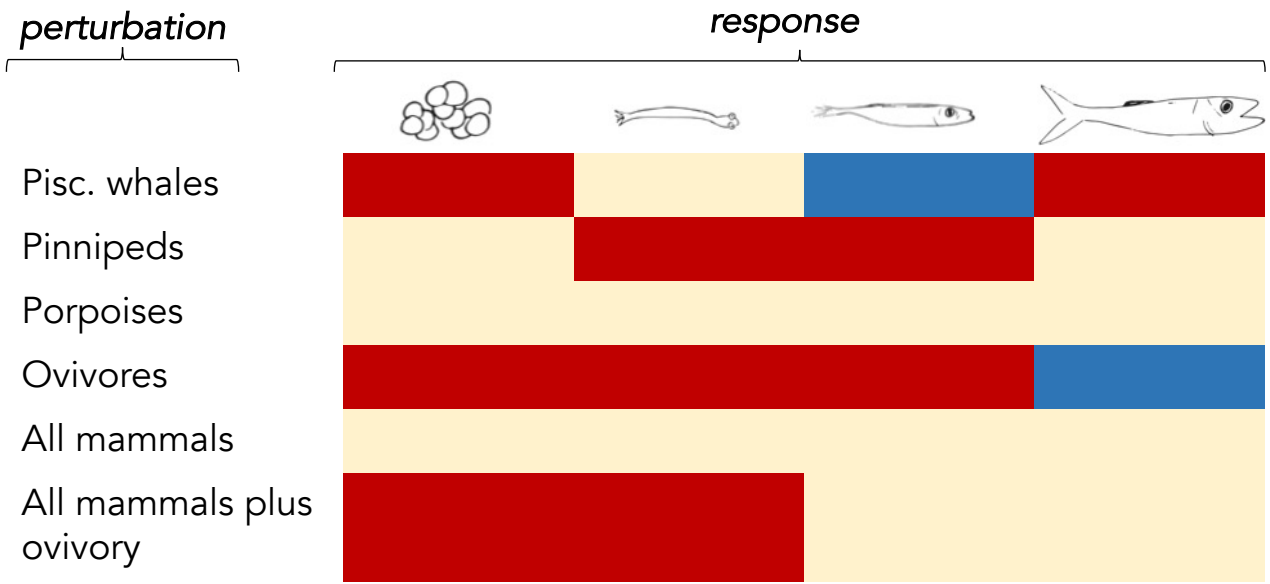
Neutral (20-80%)

Strongly positive (>80% of runs)

Scenarios: PREDATION

Bottom Line:

Only increases in piscivorous whales lead declines in adult herring abundance



Other losers:

Beach spawners, Ovivores, Orcas

Out of 10,000 stable model solutions

- Strongly negative (>80% of runs)
- Neutral (20-80%)
- Strongly positive (>80% of runs)

Scenario: SHORELINE DEVELOPMENT

↑ ARMOR

↓ eggs, larvae, juvs

perturbation

response

Armor

Eelgrass

Contaminants

Armor + Contaminants

Armor + Eelgrass + Contaminants

Out of 10,000 stable model solutions

Strongly negative (>80% of runs)

Neutral (20-80%)

Strongly positive (>80% of runs)

Scenario: SHORELINE DEVELOPMENT

Bottom Line:
Habitat effects are limited to early life stages of herring

Key Take-aways:
Armor-elgrass link matters for egg predators and planktivorous fish

Habitat impacts on larvae have little impact on model outcomes

perturbation

response

Armor
Eelgrass
Contaminants
Armor + Contaminants
Armor + Eelgrass + Contaminants

Other losers:
Beach spawners, Ovivores, Piscivorous birds, Orcas

Out of 10,000 stable model solutions

- Strongly negative (>80% of runs)
- Neutral (20-80%)
- Strongly positive (>80% of runs)

Scenario: AHBL

perturbation

response

Armor + Eelgrass + Contaminants + All Mammals + Ovivory

Other losers:

Beach spawners,
Piscivorous birds, Orcas

Out of 10,000 stable model solutions

- Strongly negative (>80% of runs)
- Neutral (20-80%)
- Strongly positive (>80% of runs)

Assumptions, caveats, next steps, other excuses

Model assumptions:

Food web packaging

No egg consumption data

Model omissions:

Shift in spawn timing

Shift in distribution/range contraction

Next steps:

Additional scenarios
Sensitivity testing
Management links
Human dimensions

Decision support:

Implementation Strategy
DFO?


SEADOC SOCIETY
PEOPLE AND SCIENCE HEALING THE SEA
WASHINGTON STATE
Recreation and
Conservation Office
I. McAllister